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# Water Crisis during Drought in District Nagaur (Rajasthan)

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***Abstract*—Naguar district has arid to semi-arid type of climate. District is frequently facing monsoon failure from last one decade. Monsoon failure resulting in widespread drought implies a deepening of the already severe water crisis. The monsoons recharge the groundwater and surface-water systems. In past, Nagaur District has over-exploited her groundwater without recharging, creating a water famine. The food and water security of the Nagaur district solely rely on the intensity of monsoon and ground water. The present paper attempts to bring a detailed study of degree of drought and possible feasible approaches of drinking water supply for Nagaur district. The study is based on the data collected by the authors on the basis of experience gathered on this subject as well as personal interactions with affected inhabitants in rural and urban areas. It is suggested that the recharging of wells using latest water conservation techniques, rehabilitation of traditional water bodies systems, better planning of water use and proper education on the topic may help in addressing the present crisis.***

***Keywords*—Drought, Rainy days, Water Management Strategies and Famine Relief**

## I. INTRODUCTION

A drought is an extended period of months or years when a region observes paucity in its water supply. It may be due to significant decrease in precipitation over a specified area or marked depletion of available surface water and fall in the water tables. On an average, 28% of the geographical area of India is susceptible to drought. The drought is just not the scarcity or absence of rainfall, but is more related to water resource management. More than 60% deficient rain fall comes in the category of severe draught. It can have a substantial impact on the ecosystem and agriculture of the affected region [3 & 12].

Rajasthan is the largest state in India covering an area of 34.22 million hectare i.e. 10.5 % of the country's geographical area but sharing only 1.15 % of its water resources. The estimated per capita water availability in the state during 2001 was 840 $m^3$ and is expected to be 439 $m^3$ by the year 2050 against the national average of 1140 $m^3$ by 2050. More than 70% of its people depend upon agricultural activities. Rajasthan experiences acute weather and consists of four distinctive seasons- Pre-monsoon, Monsoon, Post-monsoon and winter.

The average temperature in winter ranges from 2° to 26° C and in peak summer the average temperature range from 28° to 48° C making the region arid and draught-prone. Most of the area of the state (60-75%) is arid or semi arid. The conventional attitude to a drought as a phenomenon of arid and semi-arid areas is changing because even areas with high average rainfall often face acute water scarcity.

In the case of Rajasthan, there have been 52 drought years of varied intensity since 1901. At the village level, the number of drought-free years will be even less. Therefore, every year some parts of Rajasthan are affected by drought. Despite this, the State considers drought as a transient phenomenon where short term relief measures are considered to be a solution. It is estimated that one year's relief fund may be sufficient to develop rain water harvesting structures to meet drinking water requirements in rural areas of western Rajasthan [11].

**Intensity and Frequency of Drought**

Drought in Rajasthan is not an event but it is reality of life for the people of state. Drought should not be confused with only water scarcity, but it implies a long-term imbalance of all available resources and demands. During last 102 years (1901-2002), 47 droughts of varying intensity have been observed. It has also been observed that during this period, only 9 years out of 102 years, when none of the districts have observed the drought. If we are moving at block and village level, then number of drought free years may reach to zero. It is concluded that every year some or other part of Rajasthan is affected by drought. Further, as indicated in Table1, it is observed that there is not much difference in the total number of drought years among different regions in terms of severe and very severe drought occurrence years across regions also do not differ much. Further, in entire Rajasthan, 48 out of 102 years were drought years, which mean the chance of occurrence of a meteorological drought in the state is 47%. The number of severe and very severe drought years is larger in the Western and Southern districts of Rajasthan. This differs from the common perception that southern region having greater average rainfall will face fewer droughts.

***Table 1*** Frequency and Intensity of Droughts in District Nagaur and Regions of Rajasthan during 1901-2002

| Region / District | Number of years with droughts of different intensity | | | | Percentage of all drought years in the period |
|---|---|---|---|---|---|
| | Very Severe | Severe | Moderate | Light | |
| **All Rajasthan** | 10 | 10 | 15 | 13 | 47.0 |
| **Western Region** (Barmer, Jaisalmer, Bikaner, Ganganagar, Churu, Nagaur, Jodhpur, Pali and Jalore) | 12 | 12 | 11 | 11 | 45.0 |
| **NE Region** (Sikar, Jhunjhunu, Alwar, Jaipur, Ajmer, Tonk, Swai Madhopur and Bharatpur) | 12 | 8 | 11 | 16 | 46.0 |
| **Southern Region** (Bhilwar, Chittorgarh, Udipur, Sirohi, Banswara, Dungarpur, Bundi, Kota and Jhalawar | 10 | 12 | 9 | 12 | 42.1 |
| **Nagaur** | **2** | **17** | **15** | **15** | **48.5** |

Source: Based on district wise annual rainfall data and ref.[ 11]

## II. DESCRIPTION OF STUDY AREA AND DROUGHT OCCURRENCE

Nagaur District is situated between $26^0.25$" & $27^0.40$" North Latitude & $73^0.10$" & $75^0.15$" East Longitude. Nagaur is the fifth largest district in Rajasthan with a vast terrain spreading over 17,718 sq km. Its geographical spread is a good combine of plain, hills, sand mounds & as such it is a part of the great Indian Thar Desert. The district comprises of 1607 Revenue Villages, out of which Merta, Deedwana, Makarana, Parbatsar and Kuchaman are the major towns of the district. As per the 2001 census, the population of the district is 2.78 million, which is 4.91% of the total population of the State. The density of population in the district is 157, as against 165 of Rajasthan as a whole [1 & 7].

Nagaur has a dry climate with roasting summer. Sand storms are common in summer season. The climate of the district is evident by extreme dryness, large variations in dry bulb temperature & highly impulsive monsoon. The mercury keeps on rising intensely from March till July. The maximum temperature recorded in district in summer is $48^0$ C whereas $0^0$ C as the lowest recorded temperature during winter. The average temperature of the district is $23.5^0$ C. The winter season extends from mid November till the beginning of month of March. Rainy season is of a short duration, ranging from July to mid September. The average rainfall in the district is 36.16 cm. On the basis of the analysis of long series of annual data, probability of occurrence of drought in District Nagaur is once in four years as given in Table 2. Location and frequency of occurrence of droughts at the Nagaur in Rajasthan is shown in Fig.1

***Table 2:*** Frequency of drought in Rajasthan

| S.No. | Recurrence Period (Year) | Districts |
|---|---|---|
| 1 | Once in 3 years | Barmer, Jaisalmer, Jalore, Jodhpur and Sirohi |
| 2 | **Once in 4 years** | Ajmer, Bikaner, Bundi, Dungarpur, Sriganganagar, **Nagaur**, Hanumangarh and Churu |
| 3 | Once in 5 years | Alwar, Banswara, Bhilwara, Jaipur Jhunjhunu, Pali, Sawai Madhopur, Sikar, Dausa and Karauli. |
| 4 | Once in 6 years | Chittorgarh, Jhalawar, Kota, Udaipur, Tonk, Rajsamand and Baran |
| 5 | Once in 8 years | Bharatpur and Dholpur |

Ref. [13]

## III. ANNUAL RAINFALL DATA

The annual rainfall of Nagaur district varies considerably from year to year. The mean annual rainfall and extent of scarcity in the district Nagaur from the year 2002 to 2009 is indicated in the Table 3. Though the average annual rainfall in this part of Rajasthan is 361.6 mm, but it is received hardly. During the last ten years, only once it received the rainfall of 459.10 mm in the year 2003 [14]. The number of rainy days drastically changed from ten in the year 2002 to twenty six in the year 2007

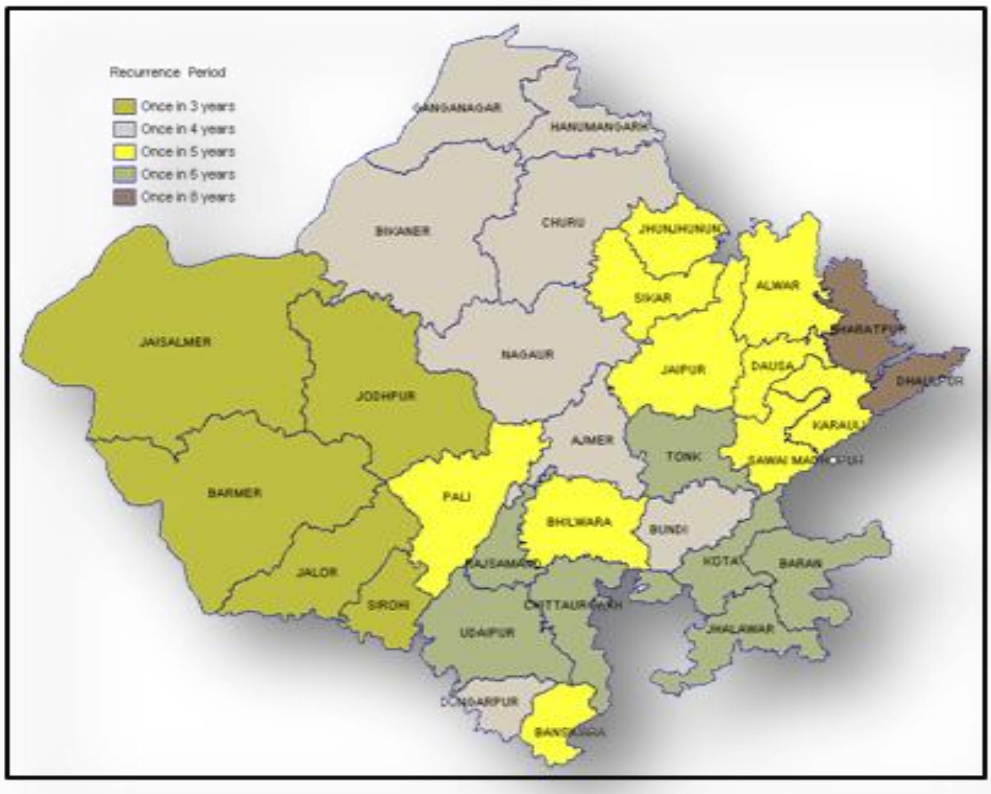


***Figure 1:*** Location and frequency of occurrence of droughts at the Nagaur in Rajasthan

## IV. EXTENT AND THE SERIOUSNESS OF THE SCARCITY

Out of the 1607 revenue villages spread over the district, 1508 villages were identified as drought-hit areas in the year 2002 and 1577 in the year 2009. More than 90 per cent of the crops were spoiled along with millions of cattle due to inadequate rainfall in these years. Except in the year 2003, almost all succeeding years were partially or completely affected by drought. The loss due to crop damage ranges from ` 583.0 million in the year 2007 to `9785.8 million in the year 2009. The district experienced severe drought in both the years.

***Table 3:*** Extent and the Seriousness of the Scarcity and Annual Rainfall in Nagaur (2002-09)

| Year | Affected Villages | Population Affected in million | Sown Area ha in million | Affected Area ha in million | Affected Cattle in million | Value of damaged crop in ` million | Annual Rainfall in mm | Annual Rainy days | Highest daily rainfall in mm |
|---|---|---|---|---|---|---|---|---|---|
| 2002 | 1508 | 1.95 | 0.587 | 0.540 | 1.957 | 3806.547 | 144.0 | 10 | 32.0 |
| 2003 | No Damage | | | | | | 459.0 | 23 | 131.0 |
| 2004 | 933 | 1.60 | 0.831 | 0.569 | 1.140 | 3829.200 | 295.0 | 21 | 41.5 |
| 2005 | 495 | 0.80 | 0.422 | 0.266 | 0.624 | 2024.970 | 387.0 | 20 | 109.0 |
| 2006 | 837 | 1.50 | 0.690 | 0.430 | 0.405 | 4690.400 | 267.0 | 15 | 38.5 |
| 2007 | 192 | 0.35 | 0.145 | 0.086 | 0.153 | 583.500 | 319.0 | 26 | 71.0 |
| 2008 | 153 | 0.25 | 0.175 | 0.112 | 0.076 | 657.100 | 433.0 | 22 | 150.0 |
| 2009 | 1577 | 2.77 | 1.162 | 0.846 | 1.053 | 9785.800 | 189.0 | 13 | 17.0 |

Source: Government of Rajasthan, Relief Department, Jaipur and based on annual rainfall data of district Nagaur

## V. FAMINE RELIEF AND FUNDS FOR DROUGHT

There is no perennial river and dam in the district. All the water supply schemes are depend only on ground water in the form of Tube well & Open well sources. Due to low potential capacity of ground water, the quaintly of potable water supply is much less than the demand required and there is a strong gap between demand and supply of water as shown in the Table 4. The surface water for the purposes of drinking is available through small village ponds. But unfortunately, due to sequel droughts, the drinking water sources started drying up literally during drought and people have started migrating to neighboring districts/states along their livestock for their lively hood. Due to the severe shortage of fodder and water,

pastoralists tend to drive their herds out of their villages in search of greener pastures. The major effect has been observed on sheep and goat migration. Thousands of sheep and goat have been died in the want of fodder and drinking water.

***Table 4**:* Computation of Demand-Supply Gap for District Nagaur

| Computation of demand-supply gap for District Nagaur | | | |
|---|---|---|---|
| | **A. Water Resources Availability** | | |
| 1 | Net Surface Water Available in the District | 188.47 | MCM |
| 2 | Net Groundwater Available in the District (Fresh water) | 548.37 | MCM |
| 3 | Total Water Resources Available | 736.84 | MCM |
| | **B. Water Demand** | | |
| 1 | Total Drinking Water Urban-Present | 5.98 | MCM |
| | Total Drinking Water Urban-As per Std Norms | 19.36 | MCM |
| | Total Drinking Water Rural | 36.44 | MCM |
| | Total Drinking Water Demand-Livestock | 19.53 | MCM |
| 2 | Total Agriculture Water Demand as per CGWB | 781.85 | MCM |
| 3 | Institutional Water Demand | 2.22 | MCM |
| 4 | Fire Fighting Water Demand | 0.86 | MCM |
| 5 | Industrial Water Demand | 5.00 | MCM |
| | Total Water Demand Present | 851.87 | MCM |
| | Total Water Demand (as per Std Norms of drinking) | 865.25 | MCM |
| | **GAP BETWEEN WATER SUPPLY & DEMAND** | 115.03 | **MCM** |

Source: Office of the Superintending Engineer PHED Circle Nagaur

To meet out the calamity in this adverse situation, the famine relief work started by the state government during drought year, are normally considered inadequate due to paucity of funds. Generally people complain of non-payment of wages as well as inadequate payment. The government is solely depends on the functioning and promptness of district collector in this situation. Funds for drought relief have been primarily available from the Calamity Relief Fund (CRF), the provision of Calamity Relief Fund was established after 1995 on recommendation of Finance Commission, expenses are shared between state and central government and funds are readily available for undertaking relief work at any point of time. National Calamity Contingency Fund (NCCF) was also established in 2001 by Eleventh Finance Commission. Allocation of additional funds from Ministries like Rural Development, Agriculture etc. and state government's own funds [13]. However, these funds are very small to meet out the expenses of food, fodder, medical relief and drinking water. The time required in getting the needed funds is too long to meet out the emergency of the situation.

## VI. WATER QUALITY AND SOURCE OF WATER SUPPLY

The state has been divided in 594 ground water potential zones; out of these 322 zones fall in "white" category, where ground water development is less than 65%, 71 zones fall in "grey" category with 65-85% stage of ground water development. The remaining 201 zones fall in "dark" category where stage of ground water development is more than 85%. Out of these 173 zones are over exploited having a stage of development more than 100%. On the basis of average rate of depletion of ground water table per year, the districts have been classified as most critical, critical and moderate. Where depletion is more than 0.4 meter per year is considered in most critical category [15]. Average post monsoon decline of water level of 0.89 meter per year computed by Central Ground Water Board (CGWB) from data of past 15 years for Nagaur district. Government of Rajasthan has been declared, Nagaur district as a dark zone due to excessive groundwater exploitation and rapid fall in ground water table.

***Table 5:*** Water Transportation and Contingency Expenditure

| S. No. | Year | Water Transportation | | | | Expenditure on contingency measures (in crores) |
|---|---|---|---|---|---|---|
| | | Urban | | Rural | | |
| | | No. of Towns | Tanker Trips per Day | No. of Habitation | No. of Tanker Trips per Day | |
| **1** | **2** | **9** | **10** | **11** | **12** | **13** |
| 1 | 2001 | 3 | 20 | 184 | 308 | 0.94 |
| 2 | 2002 | 3 | 23 | 223 | 349 | 1.05 |
| 3 | 2003 | 3 | 18 | 219 | 459 | 1.62 |
| 4 | 2004 | 2 | 15 | 207 | 507 | 2.68 |
| 5 | 2005 | 2 | 23 | 306 | 381 | 2.52 |
| 6 | 2006 | 2 | 14 | 340 | 510 | 2.83 |
| 7 | 2007 | 3 | 40 | 467 | 437 | 3.65 |
| 8 | 2008 | 3 | 54 | 507 | 525 | 5.19 |
| 9 | 2009 | 4 | 110 | 433 | 590 | 6.61 |
| 10 | 2010 | 3 | 147 | 1029 | 1296 | 10.95 |

Source: Office of the Superintending Engineer PHED Circle Nagaur

Ground water, tanks (kunds) and nearby village ponds (nadis/ talab) served to satisfy the drinking water needs during scarcity. To ensure the quality of portable water for drinking purposes, physical and chemical tests of water samples were conducted by district departmental lab with the help of central government in year 2001. The quality of drinking water was tested for fluoride, nitrate, total dissolved solids, iron and arsenic. Surprisingly, only 8.7% ground water sources were found to be fit for drinking out of total 1222 villages for which tests were conducted [2]. It is alarming situation because majority of the population depends on this unsafe water to meet their daily needs. Serious thoughts are being given to initiate the Nagaur lift water supply project which is being proposed in three phases to supply drinking water to 11 towns and 1229 villages of district from Indira Gandhi Nahar Project (IGNP) [15]. Total agriculture water demand as per CGWB is 781.85 MCM (92% of available ground water) in Nagaur district as shown in Table 4. To cope with drought, people have over- exploited groundwater mainly for food production and the situation is aggravating further, as rainfall across the district is insufficient to recharge the falling groundwater levels.

For meeting the demand of drinking water, provisions of water supply are made by district administration by using water tankers. The expenses made on transportation are shown in Table 5. It is clear from the table that every year expenses on transportation are increasing due to increase in drinking water demand. Separate provisions in budget allocation are made for meeting this emergency contingency expenditure to solve acute water problem.

## VII. WATER MANAGEMENT STRATEGIES AND DRINKING WATER SUPPLY

Drought affects all components of the water cycle; deficit in soil moisture, reduced groundwater levels and dried up ponds and reservoirs. The specific issue of droughts can be planned on the long term basis by drought management committee by keeping in mind the following remedial measures:

1. With the water crisis worsening in the desert state of Rajasthan, the state government should focus on community-based water management solutions instead of predominantly engineering-based ones. Present study depicts that the every village has community based drinking system such as village pond and Johars. The first step taken by the government is to revamp most of the ponds and Johars under the Mahatama Gandhi National Rural Employment Guarantee Act (MNREGA).
2. All the traditional water harvesting structures and sources should be renovated and people should be encouraged for roof-top rain water harvesting, storm-water harvesting, recycling and reuse of waste water under Mahatama Gandhi National Rural Employment Guarantee Act (MNREGA). . It has been noticed that the funds needed for renovating all water harvesting structures would be less as compared to the expenditures made by state government in averting the famine for one year.
3. Authors observed that people getting support from government during drought have become immune to this help and loves a good drought. They are describing this relief as the third crop. To avoid this, responsibility shall be fixed with the administrators so that such mal practices can be avoided.
4. Only less water consuming crops shall be permitted to avoid the use of excessive water in irrigation. Total consumption of ground water in irrigation is more than 90% hence this should be bringing down to 50% only by restricting the cultivation.
5. Publication of public-awareness material on water management for dissemination in schools and public buildings. Movies and documentaries shall be shown to villagers on water management techniques [7].

6. Organization of district-level coordination meetings among NGOs, government officials, and agencies involved in order to facilitate the information-sharing process and the coordination of relief interventions
7. Preparation of community-based drought proofing plans for affected communities
8. Support to the livelihood and animal husbandry sectors through employment generation and establishment of cattle camps.
9. Other domestic water saving measures should be adopted. Technical measures like preventive maintenance of supply lines, improvements in water systems network (leak detection, lining of transmission canals) and non-structural measures (information, education, pricing, restrictions on nonessential uses of water, prohibition of selected commercial uses, water rationing programs). These may change water consumptive habits [8,16].

## VIII. CONCLUSIONS

On the basis of the present study, following salient conclusions have been drawn:

1. Nagaur district has to live with drought. The experience indicates that the frequency and severity of drought is continuously increasing.
2. Bad experiences of 2002 and 2009 drought is an eye opening for the policy makers. It clearly indicates that droughts largely mean 'water famines' than 'food famines'.
3. Poor water quality may cause severe epidemic during draught.
4. It is high time to make people aware for water uses and everyone has to realize the importance of single drop of water.
5. All water harvesting techniques used in the state shall be revamped again.
6. There has to be strong linkages between policy makers, users, agriculture scientists', public health and irrigation department. Now onwards, particular area has to be year marked for a particular crop depending upon the availability of water and water consumption.
7. Water saving measures should be made mandatory to reduce the pressure on water resources. This can be achieved by implementing economical technical measures without compromising in standard of living and life style of human beings.

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